GPCS452

Good Practice
Case Study

Variable speed drive on a boiler fan

Dairy Crest Severnside

CARBON TRUST

Making business sense
of climate change

Fitting a variable speed drive to a boiler forced-draft (FD) fan can result in significant business benefits. At Dairy Crest Severnside, implementing such a measure as part of a programme of energy efficiency improvements in the site's boilerhouse has resulted in:

- **Annual cost savings of £1,890**
- **Annual energy savings of 47,200kWh**
- **Carbon savings of 5.2 tonnes/year**
- **Payback period of nine months.**

Company profile

Dairy Crest Severnside produces fresh milk in a wide range of non-returnable containers, together with fresh and UHT milk portions. It also manufactures butter, cream, buttermilk powder, skimmed milk concentrates and milkshake.

The purpose-built creamery began production in 1979 and the adjacent dairy was built in 1990. A new facility was built in 1994 to produce a range of flavoured milk drinks. The site at Stonehouse in Gloucestershire employs around 350 people and processes 1.35 million litres of milk a day, supplying major grocery retailers, large food manufacturers, fast-food chains and caterers.

Introduction

The site's continuous and large demand for steam is met from a centralised, fully automatic and unmanned boilerhouse containing five shell boilers. These supply steam at three operating pressures:

- High (2,759kPa (400psi)) — two boilers for the spray dryer
- Medium (2,069kPa (300psi)) — two boilers for the site main process load
- Low (690kPa (100psi)) — one boiler for the ingredients process.

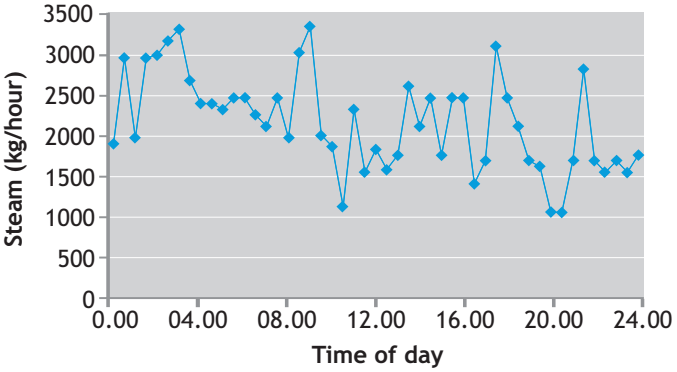
Natural gas is the predominant fuel used, with heavy fuel oil (HFO) as standby. All the boilers are fitted with dual fuel burners and have an integral FD fan. Several 'duty' combinations of the five boilers are used to meet the major variations in steam demand (due to process load demand, seasonal variations and the time of day). In 2003, the site's utility bill (including water) was £2.65 million; gas consumption amounted to 138.4GWh and electricity consumption to 47.05GWh.

Improving the performance of the low-pressure boiler

Since becoming a participant in a Climate Change Agreement in 2000, Dairy Crest has been even more conscious of the need for energy savings and improved boiler control. One energy saving opportunity identified by the company involved the low-pressure boiler, which, it was felt, could be operated more efficiently, while meeting the variations in steam demand.

The boiler's rated maximum steam output is 4,230kg/hour. However, a short period of monitoring (see Figure 1) established that the average output was 2,200kg/hour (i.e. 52% of maximum rating).

Figure 1 *Typical daily steam output from the low-pressure boiler before improvements*



To control the burner firing rate of this boiler, air was modulated by a damper in the airflow from the fixed-speed, FD fan. This resulted in large amounts of air being wasted. In addition, the fuel supply was controlled using an old, automatic, mechanical linkage unit, which was not very accurate due to hysteresis caused by wear.

One option to overcome these problems was to reduce the size of the burner to match the steam load, which would enable a smaller FD fan motor to be fitted. However, Dairy Crest was aware that

steam demand could change with the introduction of new products, and expected the average steam load to increase in the future.

Another option was to enhance the damper-controlled airflow system with a variable speed drive (VSD) system on the FD fan motor. A study of the energy consumed by this motor convinced managers that the company could achieve significant energy and carbon savings with a simple payback of less than a year on the investment.

In addition to energy and cost savings, fitting a VSD had the following potential advantages:

- Simple installation
- Longer fan motor life
- Quieter operation.

Following discussions with the burner manufacturer, Dairy Crest concluded that better control would be achieved by fitting a VSD to the FD fan motor and installing a microprocessor-based direct digital combustion control (DDCC) to accurately control the burner air/fuel ratio. Both measures involved retrofits to the low-pressure boiler and provided full optimisation through more accurate control of the air/fuel ratio. In addition to the reduced electricity use associated with the VSD, replacing the mechanical system (discussed above) with the DDCC was expected to reduce fuel use and maintenance.

The DDCC allowed direct connection to the VSD unit to accurately control the air flow. Control is achieved by a 4–20mA signal from the DDCC and feedback is a 4–20mA signal from the VSD unit into the DDCC. The air damper is still used to give a cushion of higher pressure stabilising air upstream of the damper.

Modifications to the burner fuel control system included:

- Removing the old linkage and servo unit
- Mounting the VSD unit adjacent to the burner control panel (see Figure 2)
- Installing a DDCC unit and associated wiring
- Recommissioning the burner on both fuels.

The combination of the fan controller and the fuel controller provided an integrated advanced boiler control system, which allowed Dairy Crest to optimise combustion efficiency.

Figure 2 *New VSD installed beside boiler control panel*

Assessing the savings from fitting the VSD

To establish the savings potential, Dairy Crest measured the energy used by the FD fan on the boiler before the VSD was fitted. The motor was constantly supplied at 415V and a mains frequency of 50Hz. The measured power taken by the 11kW motor was reasonably constant at about 9.75kW.

Further measurements were taken after the new DDCC and VSD had been installed. Figure 3 shows the relationship between fan motor supply frequency and power consumed. Figure 4 shows the daily variation in energy consumed by the fan motor on two typical days after fitting the VSD (energy consumption before fitting the VSD is shown for comparison). The average power consumed during this period was 2.3kW.

Figure 3 *Measured power/frequency relationship for the VSD controlled boiler fan*

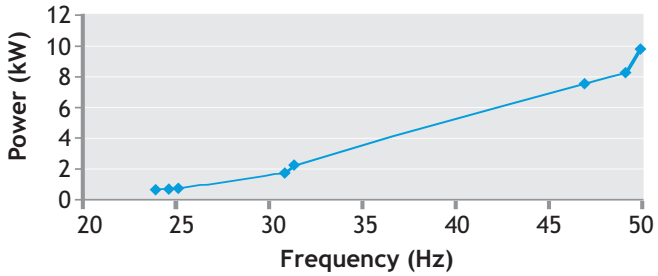
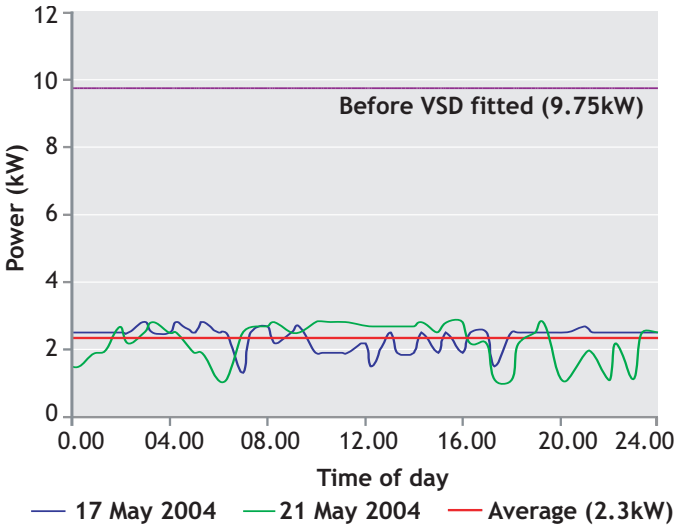


Figure 4 *Boiler fan energy consumption before and after fitting VSD*



Energy, cost and carbon savings

Table 1 summarises the savings identified by Dairy Crest from fitting the VSD. The VSD cost £1,400 to install, giving a payback period of just nine months.

Although the VSD and the new burner control system were installed at the same time, the gas savings resulting from the new electronic control system have not yet been quantified. Further unquantified savings have arisen from the reduction in the boiler's maintenance requirements following the fitting of the VSD and the new control system.

Table 1 *Annual savings from fitting the VSD to the boiler fan*

	Electricity use (kWh/year)*	Cost (£/year)**	Associated carbon emissions (tonnes/year)
FD fan motor without VSD	61,776	2,471	7.22
FD fan motor with VSD	14,572	583	1.70
Annual savings	**47,204**	**1,888**	**5.52**

* Assuming 264 days operation.
** At 4 pence/kWh.

'At Dairy Crest, we are really happy with the new variable speed drive and boiler fuel control system. I installed the VSD myself and found it simple to set up and, as a result, I have installed many similar drives on other plant in the factory. In addition to saving us money, the VSD has made my life a little easier by reducing maintenance requirements on the boiler.

We are always looking for opportunities to reduce our energy consumption and costs. This modification to the boiler has made a valuable contribution towards our commitment to savings under our Climate Change Agreement.

We are aware that we can claim tax breaks when fitting listed energy saving equipment and, as a company, will take advantage of this benefit in the future.'

Craig Pepworth, Electrical Engineering Manager, Dairy Crest Severnside

The project results have been independently verified on behalf of the Carbon Trust.

The variable speed drive was supplied by:
Danfoss Limited
Copswood
Oxford Road, Denham
Buckinghamshire
UB9 4LH
Tel. **0870 680 0008**

The combustion controls were supplied by:
Saacke Combustion and Energy Systems
Marshlands Spur
Farlington, Portsmouth
PO6 1RX
Tel: **023 9238 3111**

There may be other suppliers of similar services and energy efficiency equipment in the market. For more information, please consult your supply directories, call the Carbon Trust Energy Helpline on **0800 58 57 94**, or contact a relevant trade association.

Tax incentives

The Enhanced Capital Allowance (ECA) scheme allows businesses to deduct 100% of capital expenditure on energy efficient equipment. The Energy Technology List was set up to identify those products qualifying for ECA tax relief. It currently features over 5,000 products, including VSDs and burner controls, and continues to grow on a monthly basis. For further information about the Energy Technology List and ECAs, visit **www.eca.gov.uk** or call the helpline on **0800 58 57 94**.

Publications from the Carbon Trust

A range of free publications is available including:

GPG369 *Energy efficiency operation of boilers*

GPG002 *Guidance notes for reducing energy consumption of electric motors and drives*

GPG383 *Energy savings in fans and fan systems*

For details of Carbon Trust Energy services and free publications, call the helpline on **0800 58 57 94** or visit **www.thecarbontrust.co.uk/energy**.

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The Carbon Trust works with business and the public sector to cut carbon emissions and capture the commercial potential of low carbon technologies.

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